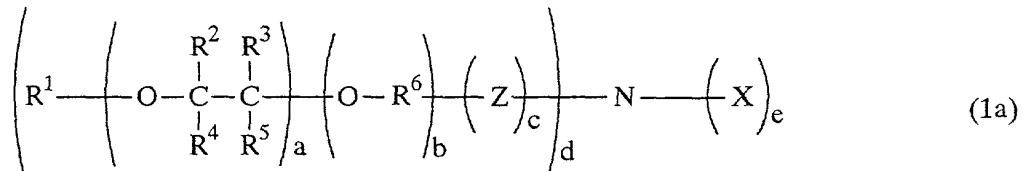


CLAIMS

What is claimed is :

1. A gasoline additive for a direct injection gasoline engine which comprises at least one nitrogen-containing compound selected from the group consisting of a compound (1A) and a polybutenylamine compound: said compound (1A) being represented by the formula

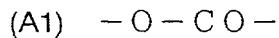


wherein R^1 is selected from the group consisting of a hydrogen and a $C_1 - C_{30}$ hydrocarbon group, R^2 , R^3 , R^4 and R^5 are each independently selected from the group consisting of a hydrogen a $C_1 - C_{16}$ hydrocarbon group and a group of formula (2a) below, a is an integer from 1 to 200, R^6 is a $C_1 - C_{10}$ hydrocarbon group, b is either 0 or 1, Z is a group selected from Group A below, c is either 0 or 1, X is a group selected from Group B below, d is an integer from 1 to 3, e is an integer from 0 to 2 and the sum of d and e is equal to 3 ,
said formula (2a) being



wherein R^7 and R^8 are each independently selected from the group consisting of a hydrogen, a $C_1 - C_{10}$ hydrocarbon group and a $C_2 - C_{10}$ alkoxyalkyl group, R^9 is either a $C_2 - C_6$ alkylene group or a $C_4 - C_{10}$ alkylene group having an alkoxyalkyl substituent, R^{10} is hydrogen or a $C_1 - C_{30}$ hydrocarbon group, and f is an integer from 0 to 50;

said Group A being constituted by



(A2) $-\text{CO}-$

(A3) $-\text{O}-\text{CO}-\text{R}^{11}-$

wherein R^{11} is a $\text{C}_1 - \text{C}_6$ alkylene group,

(A4) $-\text{O}-\text{CO}-\text{O}-\text{R}^{12}-$

wherein R^{12} is a $\text{C}_1 - \text{C}_6$ alkylene group, and

(A5) $-\text{CO}-\text{O}-\text{R}^{13}-$

wherein R^{13} is a $\text{C}_1 - \text{C}_6$ alkylene group,

said Group B being constituted by

(B1) hydrogen,

(B2) a $\text{C}_1 - \text{C}_{30}$ hydrocarbon group,

(B3) an alkanol group represented by the formula



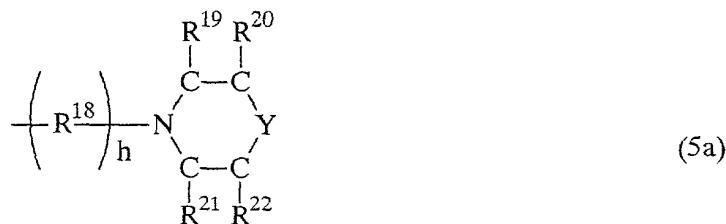
wherein R^{14} is a $\text{C}_1 - \text{C}_6$ alkylene group,

(B4) a nitrogen-containing group represented by the formula



wherein R^{15} is a $\text{C}_2 - \text{C}_6$ alkylene group, R^{16} is selected from the group consisting of a hydrogen, a $\text{C}_1 - \text{C}_4$ alkyl group or a group of formula (3a), R^{17} is selected from the group consisting of a hydrogen, a $\text{C}_1 - \text{C}_{30}$ hydrocarbon group and a group of formula (3a), and g is an integer from 1 to 5, and

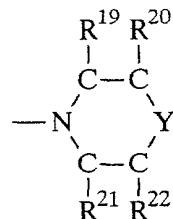
(B5) a group represented by the formula



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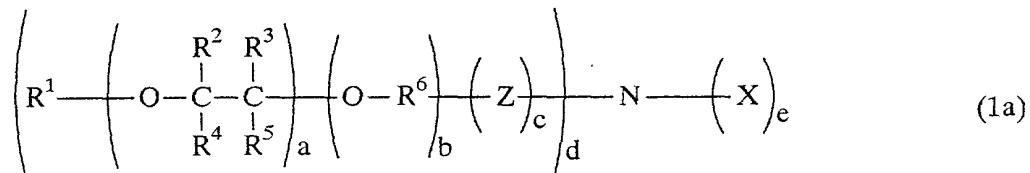
wherein R¹⁸ is a C₂ – C₆ alkylene group, R¹⁹, R²⁰, R²¹ and R²² are each independently selected from the group consisting of a hydrogen, a C₁ – C₁₀ hydrocarbon group and a hydroxyl group, Y is selected from the group consisting of a methylene group, a methylene group substituted by either a C₁ – C₁₀ hydrocarbon group, and a hydroxyl group, an imino group, an imino group substituted by a C₁ – C₁₀ hydrocarbon group or a hydroxyl group, or oxygen, h is equal to 1 if e = 1 and equal to 0 or 1 if e = 2, with the proviso that the group — N — (X)_e in formula (1a) is replaced by a group represented by formula (5a') below if h = 0;

said formula (5a') being represented by



wherein the N corresponds to the N in formula (1a) and R¹⁹ – R²² and Y are as defined in formula (5a).

2. The gasoline additive according to claim 1 wherein said component (1A) is represented by the formula



wherein R¹ is selected from the group consisting of a hydrogen, a C₁ – C₁₂ alkyl group, a C₆ – C₁₈ aryl or alkylaryl group, R², R³, R⁴ and R⁵ are each independently selected from the group consisting of a hydrogen, a C₁ – C₈ alkyl

group, and a group of formula (2a), a is an integer from 2 to 200, R⁶ is a C₁ – C₆ alkylene group, b is 0 or 1, Z is a group selected from Group A below, c is either 0 or 1, X is a group selected from Group B below, d is either 1 or 2, e is either 1 or 2 and the sum of d and e is equal to 3,
said formula (2a) being represented by



wherein R⁷ and R⁸ are each independently selected from the group consisting of a hydrogen, a C₁ – C₆ alkyl group, and a C₂ – C₆ alkoxyalkyl group, R⁹ is either a C₂ – C₆ alkylene group or a C₂ – C₈ ethylene group having an alkoxyalkyl substituent, R¹⁰ is a C₁ – C₂₄ alkyl group, and f is an integer from 0 to 30,
said Group A being constituted by

(A1) – O – C O –,

(A2) – C O –, and

(A3) – O – C O – R¹¹ –

wherein R¹¹ is a C₁ – C₄ alkylene group

(A4) – O – C O – O – R¹² –

wherein R¹² is a C₁ – C₄ alkylene group,

(A5) – C O – O – R¹³ –

wherein R¹³ is a C₁ – C₄ alkylene group

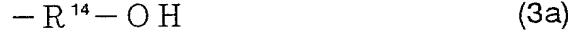
and

said Group B being constituted by

(B1) hydrogen,

(B2) a C₁ – C₁₂ alkyl group or a C₆ – C₁₂ aryl or arylalkyl group

(B3) an alkanol group represented by the formula



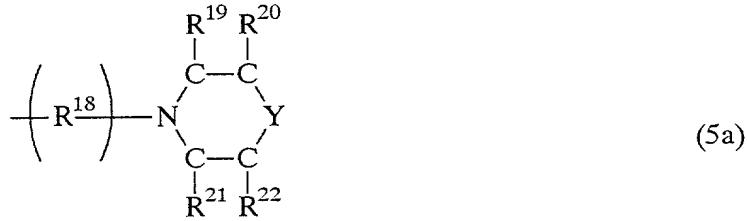
wherein R¹⁴ is a C₁ – C₄ alkylene group,

(B4) a nitrogen-containing group represented by the formula

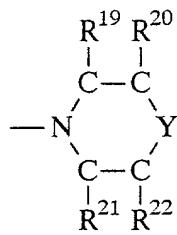


wherein R¹⁵ is a C₂ – C₄ alkylene group, R¹⁶ is selected from the group consisting of a hydrogen, a C₁ – C₃ alkyl group, and a group of formula (3a), R¹⁷ is selected from the group consisting of a hydrogen, a C₁ – C₁₂ alkyl group, a C₆ – C₁₂ aryl or arylalkyl group, and a group of formula (3a), and g is an integer from 1 to 4, and

(B5) a group represented by the formula

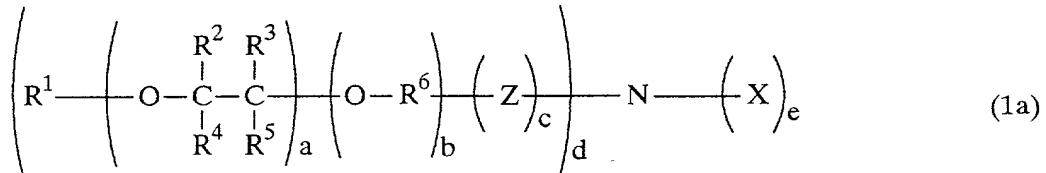


wherein R¹⁸ is a C₂ – C₄ alkylene group, R¹⁹, R²⁰, R²¹ and R²² are each independently selected from the group consisting of hydrogen, a C₁ – C₆ alkyl group, and a hydroxyl group, Y is selected from the group consisting of a methylene group, a methylene group substituted by a C₁ – C₆ alkyl group or a hydroxyl group, an imino group, an imino group substituted by a C₁ – C₆ alkyl group or a hydroxyl group, and oxygen, h is equal to 1 if e = 1 and equal to 0 or 1 if e = 2, with the proviso that the group —N —(X)_e in formula (1a) is replaced by a group represented by formula (5a') below if h = 0; said formula (5a') being represented by



wherein the N corresponds to the N in formula (1a) and R¹⁹ – R²² and Y are as defined in formula (5a).

3. The gasoline additive according to claim 1 wherein said component (1A) is represented by the formula



wherein R¹ is selected from the group consisting of a hydrogen or a C₁ – C₆ alkyl group, a phenyl group, and a C₇ – C₁₅ alkylaryl group, and wherein R², R³, R⁴ and R⁵ are each independently selected from the group consisting of a hydrogen, a C₁ – C₃ alkyl group and a group of formula (2a) below, a is an integer from 2 to 100, R⁶ is a C₃ – C₆ alkylene group, b is either 0 or 1, Z is a group selected from Group A below, c is either 0 or 1, X is a group selected from Group B below, d is 1, e is 2, and

said formula (2a) being represented by



wherein R⁷ and R⁸ are each independently selected from the group consisting of a hydrogen and a C₁ – C₃ alkyl group, R⁹ is a C₂ – C₄ alkylene group, R¹⁰ is a C₁ – C₁₂ alkyl group, and f is an integer from 0 to 20,
said Group A being constituted by

(A1) – O – C O – ,

(A2) --CO-- , and

(A4) $\text{--O--CO--O--R}^{12}\text{--}$

wherein R^{12} is a $C_1 - C_4$ alkylene group, and

said Group B being constituted by

(B1) hydrogen,

(B3) an alkanol group represented by the formula



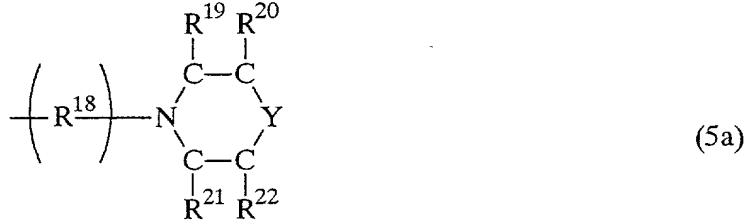
wherein R^{14} is a $C_1 - C_3$ alkylene group,

(B4) a nitrogen-containing group represented by the formula



wherein R^{15} is a $C_2 - C_3$ alkylene group, R^{16} is selected from the group consisting of a hydrogen, a methyl group, an ethyl group, and a group of formula (3a), R^{17} is selected from the group consisting of a hydrogen, a $C_1 - C_6$ alkyl group, a phenyl group, a $C_7 - C_9$ arylalkyl group and a group of formula (3a), and g is an integer from 1 to 3, and

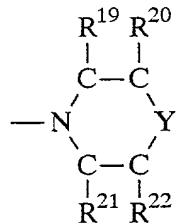
(B5) a group represented by the formula



wherein R^{18} is a $C_2 - C_3$ alkylene group, R^{19} , R^{20} , R^{21} and R^{22} are each independently selected from the group consisting of a hydrogen, a $C_1 - C_3$ alkyl group and a hydroxyl group, Y is selected from the group consisting of an imino group, an imino

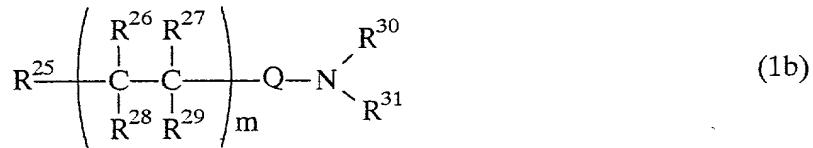
group substituted by a C₁ – C₃ alkyl group or a hydroxyl group and oxygen, h is equal to 0 or 1, with the proviso that with the group — N —(X)_e in formula (1a) is replaced by a group represented by formula (5a') below if h = 0;

said formula (5a') being represented by



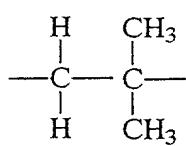
wherein the N corresponds to the N in formula (1a) and R¹⁹ – R²² and Y are as defined in formula (5a).

4. The gasoline additive according to claim 1 wherein said polybutenylamine compound is a compound (1B) represented by the formula

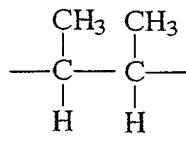


wherein R²⁵ is selected from the group consisting of an n-butyl group, a sec-butyl group, and a tert-butyl group, R²⁶, R²⁷, R²⁸ and R²⁹ are each independently a hydrogen, a methyl group and an ethyl group, and the total carbon number of R²⁶, R²⁷, R²⁸ and R²⁹ groups is 2, Q is a group represented by one of formulae (2b) to (7b) below, R³⁰ and R³¹ are each independently selected from the group consisting of a hydrogen, a C₁ – C₁₀ hydrocarbon group, a C₁ – C₈ alkanol group, and a group represented by formula (8b) below, and m is an integer from 1 to 100,

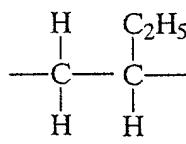
said formulae (2b) to (7b) being represented by



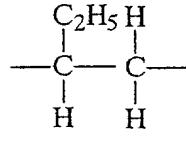
(2b)



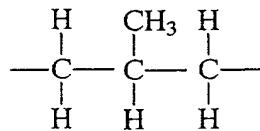
(3b)



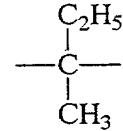
(4b)



(5b)

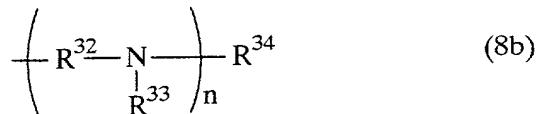


(6b)



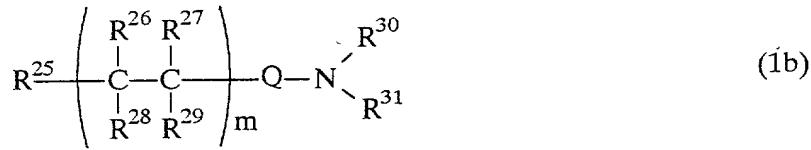
(7b)

said formula (8b) being represented by



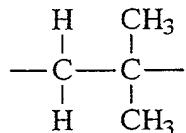
wherein R^{32} is a $\text{C}_1 - \text{C}_4$ alkylene group, R^{33} is either a hydrogen or a $\text{C}_1 - \text{C}_4$ alkyl group, R^{34} is either a hydrogen or a $\text{C}_1 - \text{C}_{10}$ hydrocarbon group, and n is an integer from 1 to 5.

5. The gasoline additive according to claim 4 wherein said compound (1B) is represented by the formula

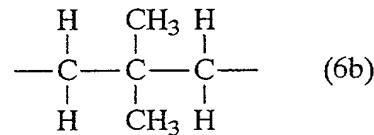


wherein either (i) R^{25} is a tert-butyl group, R^{26} and R^{28} are each hydrogen and R^{27} and R^{29} are each a methyl group, or (ii) R^{25} is a tert-butyl group, R^{26} and R^{28} are each a methyl group and R^{27} and R^{29} are each hydrogen, Q is a group represented by formula (2b) or (6b) below, R^{30} and R^{31} are each independently selected from the group consisting of a hydrogen, a $\text{C}_1 - \text{C}_{10}$ alkyl group, a $\text{C}_2 - \text{C}_{10}$ alkenyl group, a $\text{C}_5 - \text{C}_{10}$ cycloalkyl or alkylcycloalkyl group, a $\text{C}_6 - \text{C}_{10}$ aryl or

alkylaryl group, a $C_7 - C_{10}$ arylalkyl group, a $C_1 - C_8$ alkanol group, and a group represented by formula (8b) below, and m is an integer from 5 to 50, said formulae (2b) and (6b) being represented by

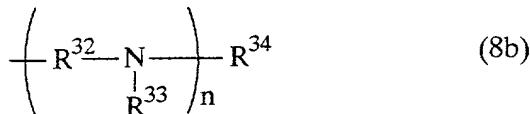


(2b)



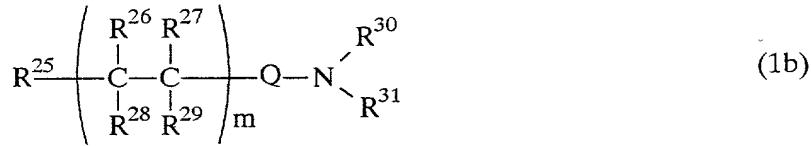
(6b)

said formula (8b) being represented by

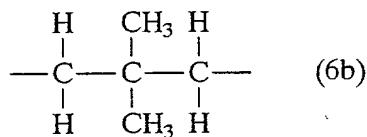


wherein R^{32} is a $C_1 - C_3$ alkylene group, R^{33} is either hydrogen or a $C_1 - C_3$ alkyl group, R^{34} is either hydrogen or a $C_1 - C_3$ alkyl group, and n is an integer from 1 to 3.

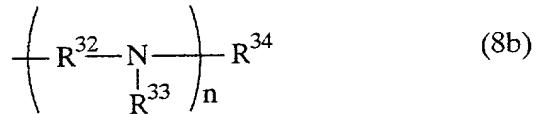
6. The gasoline additive according to claim 4 wherein said compound (1B) is represented by the formula



wherein either (i) R^{25} is tert-butyl group, R^{26} and R^{28} are each hydrogen and R^{27} and R^{29} are each methyl group or (ii) R^{25} is tert-butyl group, R^{26} and R^{28} are each methyl group and R^{27} and R^{29} are each a hydrogen atom, Q is a group represented by formula (6b), R^{30} and R^{31} are each independently selected from the group consisting of a hydrogen, a $C_1 - C_{10}$ alkyl group, a $C_2 - C_{10}$ alkenyl group, a $C_5 - C_{10}$ cycloalkyl or alkylcycloalkyl group, a $C_6 - C_{10}$ aryl or alkylaryl group, a $C_7 - C_{10}$ arylalkyl group, a $C_1 - C_4$ alkanol group, and a group represented by formula (8b) below and m is an integer from 10 to 40, said formulae (6b) being represented by



said formula (8b) being represented by



wherein R^{32} is a $\text{C}_1 - \text{C}_3$ alkylene group, R^{33} and R^{34} is each a hydrogen, and n is an integer of 1.

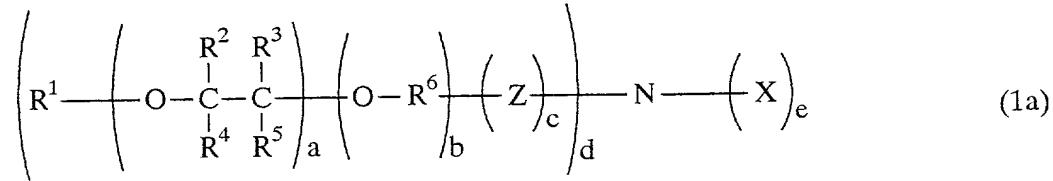
7. The gasoline additive according to claim 4 wherein the number-average molecular weight of said compound (1B) is within the range of 200 to 6,000.

8. The gasoline additive according to claim 4 wherein the number-average molecular weight of said compound (1B) is within the range of 400 to 3,000.

9. The gasoline additive according to claim 4 wherein the number-average molecular weight of said compound (1B) is within the range of 700 to 2,400.

10. A gasoline composition for use in a direct injection gasoline engine, which composition comprises a base gasoline and at least one nitrogen-containing compound selected from the group consisting of compound (1A) and a polybutenylamine compound:

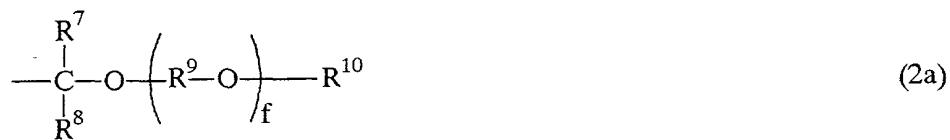
said compound (1A) being represented by the formula



wherein R^1 is either a hydrogen or a $\text{C}_1 - \text{C}_{30}$ hydrocarbon group, R^2 , R^3 , R^4 and

R^5 are each independently selected from the group consisting of a hydrogen, a $C_1 - C_{16}$ hydrocarbon group, and a group of formula (2a) below, a is an integer from 1 to 200, R^6 is a $C_1 - C_{10}$ hydrocarbon group, b is either 0 or 1, Z is a group selected from Group A below, c is either 0 or 1, X is a group selected from Group B below, d is an integer from 1 to 3, e is an integer from 0 to 2, and the sum of d and e is equal to 3,

said formula (2a) being



wherein R^7 and R^8 are each independently selected from the group consisting of a hydrogen, a $C_1 - C_{10}$ hydrocarbon group and a $C_2 - C_{10}$ alkoxyalkyl group, R^9 is either a $C_2 - C_6$ alkylene group or a $C_4 - C_{10}$ alkylene group having an alkoxyalkyl substituent, R^{10} is a $C_1 - C_{30}$ hydrocarbon group, and f is an integer from 0 to 50,

said Group A being constituted by

(A1) $-O-CO-$

(A2) $-CO-$

(A3) $-O-CO-R^{11}-$

wherein R^{11} is a $C_1 - C_6$ alkylene group,

(A4) $-O-CO-O-R^{12}-$

wherein R^{12} is a $C_1 - C_6$ alkylene group, and

(A5) $-CO-O-R^{13}-$

wherein R^{13} is a $C_1 - C_6$ alkylene group,

said Group B being constituted by

(B1) hydrogen,

(B2) a $C_1 - C_{30}$ hydrocarbon group,

(B3) an alkanol group represented by the formula



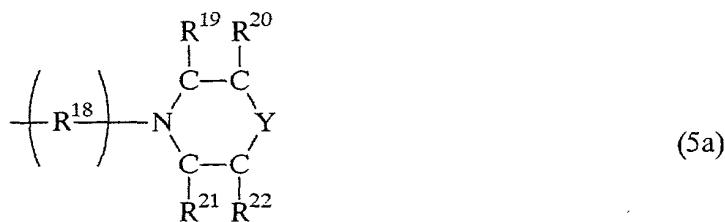
wherein R^{14} is a $\text{C}_1 - \text{C}_6$ alkylene group,

(B4) a nitrogen-containing group represented by the formula



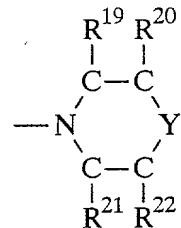
wherein R^{15} is a $\text{C}_2 - \text{C}_6$ alkylene group, R^{16} is selected from the group consisting of a hydrogen, a $\text{C}_1 - \text{C}_4$ alkyl group and a group of formula (3a), R^{17} is selected from the group consisting of a hydrogen, a $\text{C}_1 - \text{C}_{30}$ hydrocarbon group, and a group of formula (3a), and g is an integer of between 1 and 5, and

(B5) a group represented by the formula



wherein R^{18} is a $\text{C}_2 - \text{C}_6$ alkylene group, R^{19} , R^{20} , R^{21} and R^{22} are each independently selected from the group consisting of a hydrogen, a $\text{C}_1 - \text{C}_{10}$ hydrocarbon group, and a hydroxyl group, Y is selected from the group consisting of a methylene group, a methylene group substituted by a $\text{C}_1 - \text{C}_{10}$ hydrocarbon group or a hydroxyl group, an imino group, an imino group substituted by a $\text{C}_1 - \text{C}_{10}$ hydrocarbon group or a hydroxyl group, and oxygen, h is equal to 1 if $e = 1$ and equal to 0 or 1 if $e = 2$, with the proviso that the group $-\text{N}-(\text{X})_e$ in formula (1a) is replaced by a group represented by formula (5a') below if $h = 0$;

said formula (5a') being represented by



wherein the N corresponds to the N in formula (1a) and R¹⁹—R²² and Y are as defined in formula (5a).

11. The gasoline composition according to claim 10 wherein said compound (1A) is contained in an amount of 0.001 to 10 mass percent, based on the total composition.

12. The gasoline composition according to claim 10 wherein said polybutenylamine compound is contained in an amount of 0.001 to 10 mass percent, based on the total composition.